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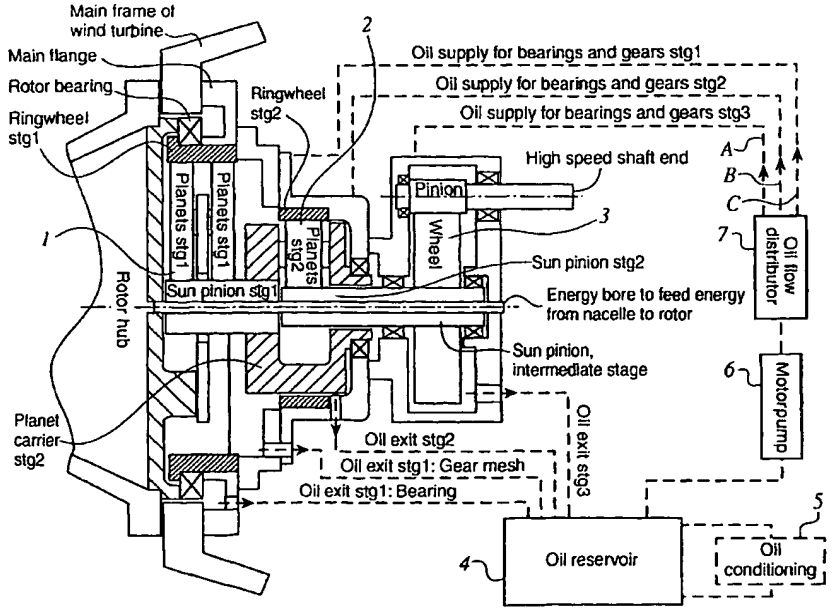
(54) Title: DRY SUMP LUBRICATION SYSTEM WITH REMOVABLE OIL RESERVOIR FOR WIND TURBINE GEARBOX



(57) Abstract: A gear unit for use in wind turbine applications has a dry sump and is lubricated from an external reservoir whereby routine oil change may be undertaken by removing an external reservoir containing used oil and replacing it by a reservoir containing fresh oil.

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DRY SUMP LUBRICATION SYSTEM WITH REMOVABLE OIL RESERVOIR FOR WIND TURBINE GEARBOX

The present invention relates to a gear unit and particularly but not exclusively to a gear unit for a wind turbine.

Because of their position high up in the nacelle, a key success factor of gear units for wind turbines is to provide low weight and compactness. This has lead in the last decade to the quasi general introduction of planetary low speed gear stages for gear units in the power range beyond 500 kW and is now, in the development of multi-MegaWatt turbines, leading to more and more gear units with planetary low speed and intermediate gear stages.

This evolution is leading to new challenges for the designers of such turbines.

A basic characteristic of a planetary gear stage is that it can contain only a very limited quantity of oil. A minimum quantity of oil however is required in the lubrication system of the gear unit to ensure that the oil does not degrade too fast and oil change intervals are maximized.

At the same time, requiring large oil quantities complicates oil changes on top of the nacelle due to cost and time involved in the transport of oil barrels, draining and filling of the gear unit

By the nature of its construction, there are several disadvantages to using the gear unit housing as the oil reservoir : the oil is continuously churned around which leads to efficiency losses and high cold-start torques, as well as possibly faster oxidation because of a more intense contact of the oil with air, foam building that can disturb lubrication systems and for instance oil level alarms, etceteras.

Gear units typically contain several oil pockets that are hard to flush when the oil is changed. Also, contamination of the oil bath due to a failing component may easily lead to consequential damage of other components as the particles from the failing component are coming in the common oil sump of the gear unit.

The present invention provides a novel solution for the specific problems mentioned above.

The basic idea of the present invention is to completely eliminate the oil sump in the gear unit. A seperate oil reservoir is installed, from which well conditioned (cooled and filtered) oil is fed to the gear unit. Although central lubrication systems exist that provide oil for instance to different gear units in the same plant or even to a single gear unit, these gear units mostly still also need to enjoy the benefit of their own oil baths. Also the use of external oil reservoirs, which in general would be regarded as contrary to the objective of compactness, is not known in wind turbine gear unit design.

Eliminating the oil bath in the gear unit as a whole however can solve a number of the issues mentioned above. The uncoupling of the gear unit lubrication circuit from the oil conditioning circuit by means of an external oil reservoir moreover simplifies the monitoring of the oil conditioning equipment itself, such as oil heaters, cooling systems and filter systems.

As a further part of this invention, the gear unit is constructed in such a way that the main gear stages are forming seperate modules, each of which receives fresh conditioned oil from the lubrication system and returns the used oil seperately to the external oil reservoir. This has the advantage that

contaminating particles in one of the modules, for instance created by a failing component or by external factors such as dirt or water accumulation, are not allowed to contaminate the other modules, but are intercepted by the separate oil conditioning system of the reservoir.

Each of the return lines can be provided with a debris trap device for instance by means of a transparent small reservoir provided with a magnet and allowing visual inspection of the presence of particles or debris.

Furthermore, the present invention also proposes to use an oil reservoir that can be easily removed from the nacelle and replaced by another fresh oil reservoir that contains well conditioned oil. This exchange may include the most important parts of the oil conditioning unit such as heaters, coolers and filtration systems. The lubrication system thus receives a complete "reset" at any oil change, removing all possibly accumulated dirt or debris and also avoiding time consuming flushing of oil tanks on-board of the nacelle. Against a background of a growing off-shore market for wind turbines that are even more difficult to service, this may be a large advantage.

A particulary interesting embodiment of the present invention is shown in Figure 1 which shows a schematic diagram of cross-section of a gear unit and plural lubrication circuits A, B, C and each serving a different module of the gear unit.

The shown gear unit consists of three modules comprising two planetary gear stages 1 and 2 and a helical high speed gear stage 3. The wind turbine rotor bearing arrangement is integrated in the gear unit.

Fresh oil is fed from the external reservoir 4 by means a pump 6 and via a flow distributor 7 to the three different modules of the gear unit, and returned from these modules back to the reservoir. The reservoir is provided with a separate oil conditioning circuit 5.

For this particular construction, the invention with a dry sump offers the additional advantage that the sealing arrangement which has to be provided at a very large diameter, does not have to seal of against any hydrostatic pressure that would be present in case of an oil sump, and can therefore be based on non-contacting sealing principles.

CLAIMS

1. Gear unit for use in wind turbine applications characterised by the fact that the gear unit has a dry sump and is lubricated from an external reservoir

2. Gear unit according to claim 1 characterised by the fact that the gear unit consist of several modules each of which receives fresh oil from the lubrication system and returns the used oil to the external reservoir.

3. Gear unit according to claim 1 and 2 characterised by the fact that each return line is equipped with a debris trap device allowing evaluation of each of the modules.

4. Gear unit according to claim 1 characterised by the fact that the regular oil change is carried out by removing the complete external oil reservoir and replacing it with a fresh oil reservoir

5. Gear unit according to claim 3 characterised by the fact that not only the oil reservoir is exchanged at the time of oil change, but also a number of dedicated parts of the oil conditioning system attached to the reservoir.

6. Gear unit according to claim 1 and 2 characterised by the fact that the gear unit comprises an integrated wind turbine rotor bearing arrangement that is also lubricated with fresh oil from the same reservoir.

7. Gear unit according to claim 5 characterised by the fact that the gear unit is sealed at a large diameter by a sealing arrangement whose function is based on non contacting sealing principles.

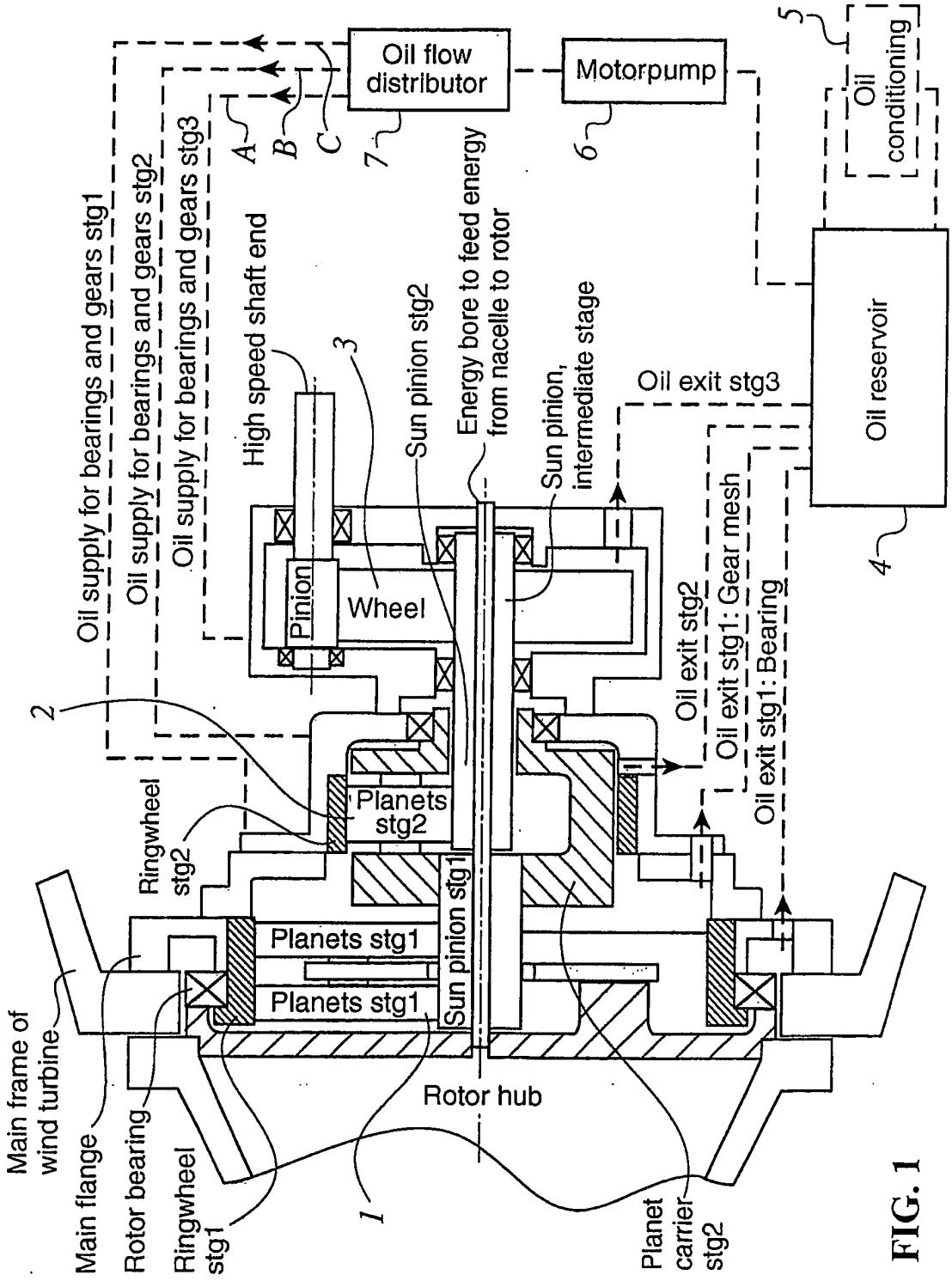
Oil flow distributor
Motorpump
Oil conditioning
Oil reservoir
Oil supply for bearings and gears stg1
Oil supply for bearings and gears stg2
Oil supply for bearings and gears stg3
A
B
C
7
6
5
4
High speed shaft end
3
Sun pinion stg2
Energy bore to feed energy from nacelle to rotor
Sun pinion, intermediate stage
Oil exit stg3
Oil exit stg2
Oil exit stg1: Gear mesh
Oil exit stg1: Bearing
Pinion
Wheel
2
Ringwheel stg2
Planets stg2
Sun pinion stg1
Planets stg1
Planets stg1
Main frame of wind turbine
Main flange
Rotor bearing
Ringwheel stg1
Rotor hub
1
Planet carrier stg2

FIG. 1

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D1/00 F03D11/02 F03D11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 December 2002	02/01/2003

Name and mailing address of the ISA	Authorized officer
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